Introduction to special section on Toward Reducing Cloud-Climate Uncertainties in Atmospheric General Circulation Models

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Received 28 February 2005; revised 3 March 2005; accepted 8 March 2005; published 14 June 2005.

Citation: Zhang, M., S. Klein, D. Randall, R. Cederwall, and A. Del Genio (2005), Introduction to special section on Toward Reducing Cloud-Climate Uncertainties in Atmospheric General Circulation Models, *J. Geophys. Res.*, *110*, D15S01, doi:10.1029/2005JD005923.

[1] Uncertainties of global warming projections have not changed much in general circulation models (GCMs) in the last 20 years. For example, in the first, second, and third reports of the Intergovernmental Panel on Climate Change (IPCC), the ranges of global warming simulated in GCMs are 1.9° to 5.2°C [*Mitchell et al.*, 1990], 2.1° to 4.6°C [*Kattenberg et al.*, 1996], and 2.0° to 5.1°C [*Cubasch et al.*, 2001] respectively. These discrepancies in model's climate sensitivities can been largely attributed to differences in their cloud-climate feedback processes [e.g., *Cess et al.*, 1990; *Soden et al.*, 2004].

[2] Many research efforts have therefore been directed to understand how cloud feedbacks operate in a climate change, with the hope to design models that can correctly describe them in a climate change scenario. It is however well known that cloud feedbacks are sensitive to perturbations of physical parameterizations and subgrid-scale processes in the models that are well justifiable at the present time.

[3] Thus the search to magically find a "correct" model may well be analogous to the search for "The Gold in the Orchard," the story of the three sons trying to find the hidden gold in an orchard. In this Italian folk tale, an elderly farmer called his three sons to his deathbed to tell them that there was a pot of gold buried in the family orchard. After his death, the three sons dug up the whole orchard but found no gold. In the next season, however, the olive trees bore a lot more fruits than usual. When they were sold, they gave the sons a whole pot of gold.

[4] The story reminds us of two things. First, there might be no such thing as a model with the correct cloud-climate feedback unless all aspects of the model are right. Second, the hard work of digging can lead to real payoff through a different direction. The articles in this special issue represent a glimpse of the efforts of the Cloud Parameterization and Modeling Working Group (CPM) of the Atmospheric Radiation Measurement Program (ARM) of the U. S. Department of Energy in digging the orchard: understanding and improving model clouds by using observations at the process levels, with the purpose of reducing cloud-feedback uncertainties in atmospheric general circulation models.

[5] The first paper in this section reports an assessment of the current status of cloud simulations in GCMs, with participations of most climate modeling centers in the United States and in Europe. The remaining seventeen papers can be categorized into four groups that appear in order in this section. The first group focuses on a case study of cloud simulations during the March 2000 ARM Intensive Cloud Field Campaign, designated as the ARM/GCSS (Global Energy and Water Experiments–Cloud System Studies) case 4, following earlier studies of ARM/GCSS case 1 [*Ghan et al.*, 2000] and ARM/GCSS Case 3 [*Xie et al.*, 2002; *Xu et al.*, 2002]. The second group of papers describes developments of cloud parameterization algorithms using ARM data. The third group of papers evaluates model cloud processes against ARM measurements. The last group of papers describes research results concerning measurements of clouds.

[6] These papers may have raised more questions than solutions. They, however, collectively expose many issues that have to be dealt with in order to design GCMs that can correctly describe cloud-climate feedback processes: the gold in the orchard.

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